INTRODUCTION TO ENGINEERING DESIGN (non-PLTW)

Introduction to Engineering Design is an introductory course which develops student problem solving skills using the design process. Students document their progress of solutions as they move through the design process. Students develop solutions using elements of design and manufacturability concepts. They develop hand sketches using 2D and 3D drawing techniques. Computer Aided Design (CAD).

- DOE Code: 4802
- Recommended Grade Level: Grade 9-12
- Recommended Prerequisites: none
- Credits: 1 credit per semester, maximum of 2 credits
- Counts as a Directed Elective or Elective for the General, Core 40, Core 40 with Academic Honors and Core 40 with Technical Honors diplomas

Application of Content

Intensive laboratory applications are a component of this course and may be either school based or work based or a combination of the two. Work-based learning experiences should be in a closely related industry setting. Instructors shall have a standards-based training plan for students participating in work-based learning experiences.

Content Standards

Domain – Design Process
Core Standard 1 Students perform the steps of the design process to develop and analyze products and systems.

> **Standards**
>
> IED-1.1   Describe and apply problem solving techniques
>
> IED-1.2   Identify and describe the steps in the design process
>
> IED-1.3   Compare the design processes specific to the subject matter
>
> IED-1.4   Apply and adapt the design loop as a guide in creating a solution
>
> IED-1.5   Discuss the importance of the design process and how the process affects the outcome

Domain – Drawing Standards
Core Standard 2 Students integrate drawing standards to produce industry standard sketches and drawings.

> **Standards**
>
> IED-2.1   Choose when different line types should be utilized during the drawing process
>
> IED-2.2   Select appropriate annotation to appropriately document features within drawings
>
> IED-2.3   Recognize and explain the various tolerances and their purpose
>
> IED-2.4   Verify sizes and shapes of objects utilizing differing measurement tools
>
> IED-2.5   Identify appropriate views and be able to select which should be utilized in a given situation
>
> IED-2.6   Develop drawings in isometric, orthographic, and perspective views
>
> IED-2.7   Evaluate when geometric shapes can be utilized as a part of a design

IED-2.8   Determine how and where calculations can be made to quantify the size and locations of designs

Domain – Reverse Engineering

Core Standard 3 Students perform various analyses of systems or products with the purpose of developing improvements to those systems or products.

Standards

IED-3.1   Perform product analyses (visual, functional, and structural) on a product

IED-3.2   Differentiate between invention and innovation

IED-3.3   Distinguish the relationship between reverse engineering and the next step of product/system improvement

IED-3.4   Use information from product analyses create an innovation to a system or product

Domain – Project Management

Core Standard 4 Students manage information and data to provide better productivity through the use of engineering design process and notebook.

Standards

IED-4.1   Justify the necessity of producing an engineering notebook

IED-4.2   Identify the requirements for and role of intellectual property in design

IED-4.3   Develop a working engineering notebook according to appropriate standards

IED-4.4   Understand, develop, and implement design briefs in relation to a design problem

IED-4.5   Understand the purpose of technical reports

IED-4.6   Collaborate on various projects by working in design teams

IED-4.7   Develop a Gantt chart to manage the time and progress of a project

IED-4.8   Develop a portfolio to organize and display evidence of work

Domain – Engineering Design

Core Standard 5 Students assess the components and ethics of engineering design to understand their role in the design process.

Standards

IED-5.1   Recognize and explain the design principles

IED-5.2   Recognize and explain the design elements

IED-5.3   Justify the importance of ethics in engineering design

IED-5.4   Recognize historical and current events related to engineering design and their effects on society

IED-5.5   Understand the effective use of engineering design equipment

IED-5.6   Recognize and identify the role of engineering and engineered products in society

IED-5.7   Identify the qualities of good design and their relationship to the design's user

IED-5.8   Examine a design with respect to its quality and usability

IED-5.9   Understand that these qualities are the result of choices made and constraints applied during the design process

Domain – Modeling

Core Standard 6 Students create designs using a variety of modeling techniques to communicate information

Standards

IED-6.1 Communicate conceptual ideas through written and verbal formats

IED-6.2 Select the appropriate modeling materials to complete a 3-dimensional prototype or mock-up

IED-6.3 Evaluate a sketch and generate a model using appropriate modeling materials

IED-6.4 Recognize and explain constraints in regard to modeling

IED-6.5 Identify the six degrees of freedom

IED-6.6 Differentiate between assemblies and subassemblies and their appropriate use

Domain – Aesthetics

Core Standard 7 Students demonstrate artistic fundamentals which are utilized throughout the design process to solve visual problems and communicate ideas for a product or system.

Standards

IED-7.1 Identify the knowledge and skills gained in art experiences that transfer to the design process

IED-7.2 Analyze the effective use of symbols, elements, principles, and media using appropriate terminology

IED-7.3 Construct insightful, convincing interpretations of products or systems by identifying problematic features, forming theories, and evaluating alternative theories

IED-7.4 Engage in critical reading, writing, and discourse to improve understanding of own work and that of others

IED-7.5 Demonstrate skill in perception from real life to present convincing representation of objects or subject matter

IED-7.6 Select subject matter, symbols, and ideas to communicate statements to the consumer

IED-7.7 Engage in philosophical inquiry into the nature aesthetic issues independently or with others

IED-7.8 Make informed choices about specific subject matter or concepts and defend those choices when given a range of objects or spaces

IED-7.9 Appropriate symbols and metaphors from art and design and describe their origin, function, and value in the solutions

IED-7.10 Demonstrate thoughtful revision and refinement of original design solutions based upon reflection, critique, practice, and research

IED-7.11 Examine and establish criteria for judging excellence in work and revise and refine work through analysis, synthesis, peer critique, and self-evaluation, utilizing established criteria for the purpose of creating portfolio level work

IED-7.12 Evaluate the effectiveness of elements and principles in other design solutions and use this evaluation to inform personal work

IED-7.13 Create multiple solutions in works that demonstrate competence in producing effective relationships between elements, media, and function

IED-7.14 Create design solutions that use specific elements, principles, and functions to solve problems and communicate ideas

IED-7.15 Create design solutions that demonstrate skill and understanding of different media, processes and communicate ideas

IED-7.16 Begin, define, and solve challenging visual problems, demonstrating skill and in-depth understanding of media and processes

Common Core Literacy Standards for Technical Subjects

Reading Standards for Literacy in Technical Subjects 9-10

The standards below begin at grade 9 and define what students should understand and be able to do by the end of grade 10. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations – the former providing broad standards, the latter providing additional specificity.

Key Ideas and Details

9-10.RT.1   Cite specific textual evidence to support analysis of technical texts, attending to the precise details of explanations or descriptions.

9-10.RT.2   Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

9-10.RT.3   Follow precisely a complex multistep procedure when performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure

9-10.RT.4   Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific context relevant to *grades 9-10 texts and topics*.

9-10.RT.5   Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

9-10.RT.6   Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Integration of Knowledge and Idea

9-10.RT.7   Translate technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

9-10.RT.8   Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a technical problem.

9-10.RT.9   Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity

9-10.RT.10   By the end of grade 10, read and comprehend technical texts in the grades 9-10 text complexity band independently and proficiently

Writing Standards for Literacy in Technical Subjects 9-10

The standards below begin at grade 9 and define what students should understand and be able to do by the end of grade 10. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations – the former providing broad standards, the latter providing additional specificity.

Text Types and Purposes

9-10.WT.1   Write arguments focused on *discipline-specific content*.

9-10.WT.2   Write informative/explanatory texts, including technical processes.

9-10.WT.3   Students will not write narratives in technical subjects. *Note: Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In technical, students must be able to write precise enough descriptions of the step-by-step procedures they use in their technical work that others can replicate them and (possibly) reach the same results.*

Production and Distribution of Writing

9-10.WT.4   Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

9-10.WT.5   Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

9-10.WT.6   Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Research to Build and Present Knowledge

9-10.WT.7   Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

9-10.WT.8   Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectivity to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation

9-10.WT.9   Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

9-10.WT.10   Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Career and Technical Student Organizations

Career and Technical Student Organizations are considered a powerful instructional tool when integrated into Career and Technical Education programs. They enhance the knowledge and skills students learn in a course by allowing a student to participate in a unique program of career and leadership development. Students should be encouraged to participate in a Career and Technical Student Organization, such as Business Professional of America, DECA, or Future Business Leaders of America.